DOCUMENT RESUME

ED 205 370 SE 035 237

AUTHOR Gann, Louise L.; Fowler, H. Seymour
TITLE An Experimental Study into the Effect of Science Teaching on the Fourth-Grade Child's Concept of Piagetian Physical Causality.
PUB DATE Apr 81
NOTE 16p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (54th, Grossinger's in the Catskills, Ellenville, NY, April 5-8, 1981).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Cognitive Development; Concept Formation; Concept Teaching; Control Groups; *Developmental Stages; *Elementary School Science; Elementary School Students; Experimental Groups; Grade 4; Intermediate Grades; Science Education; Science Instruction; Scientific Concepts; *Sex Differences
IDENTIFIERS *Piaget (Jean); *Science Education Research

ABSTRACT

The purpose of this study was to investigate the effect of selected science experiences on fourth-grade students' concepts of Piagetian physical causality, namely, animism and dynamism. Vocabulary ability and Piagetian developmental stages were assessed by the "Concept Assessment Kit Conservation" and "Metropolitan Achievement Test." Three-hundred minutes were devoted to instruction during the treatment phase of the study, 150 minutes to teaching the cause of floating to the experimental group followed by 150 minutes to teaching the definition of the term "living." A control group was given 300 minutes of language arts instruction. Post-testing using the "Concept Assessment Kit Conservation" was done to identify subjects who had changed in developmental stage. Causal stage was assessed by means of two clinical interviews: the first variable dealing with students' concept of "living," and the second considering students' concept of the cause of floating. Findings indicated that experimental group performance was greater than control group performance. Differences between the sexes were also reported. Concludes that animism and dynamism can be taught to fourth-grade children and that children who were classified as concrete operational had acquired the necessary cognitive structures to conserve, do reversible thinking, and make multiple comparisons. (Author/SK)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED205370

An Experimental Study into the Effect of Science Teaching on the Fourth-Grade Child's Concept of Piagetian Physical Causality

by

Louise L. Gann
Alcoa Elementary School
Alcoa, Tennessee

H Seymour Fowler
The Pennsylvania State University
University Park, Pennsylvania

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
LOUISE L. GANN
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

A Paper presented at the National Convention of the National Association for Research in Science Teaching, New York, April, 1981

SE 035 237

ABSTRACT

The purpose of the present study was to investigate the effect of selected science experiences on the students' concepts of Piagetian physical causality. Fourth-grade children served as subjects.

The specific Piagetian causal concepts tested were animism and dynamism.

The independent variables of Piagetian developmental stage and vocabulary ability were assessed through the use of the Concept Assessment Kit - Conservation (Form A) and the Metropolitan Achievement Test (Form F). Prior to the testing of the subjects, students had been randomly assigned to four home-room teachers. Groups one and three were chosen for the control group. Groups two and four were chosen for the experimental group.

During the treatment phase of the study 300 minutes was devoted to instruction, with the first 150 minutes devoted to teaching the cause of floating to the experimental group. The second 150 minutes was devoted to the teaching of the definition of the term "living."

The control group was given 300 minutes of language arts instruction as a placebo. All lessons used were evaluated by the fourth-grade teachers working with the students in the other subject areas.

Upon completion of the treatment phase, posttesting was conducted. The Concept Assessment Kit - Conservation (Form A) was readministered for the purpose of identifying those subjects who had changed from one developmental stage to another. A change in developmental stage was considered an independent variable during the analysis of the data. The dependent variable of causal stage was assessed by means of two

clinical interviews. The first interview dealt with students' concepts of "living," while the second considered the students' concept of the cause of floating.

Analysis of the data revealed a number of significant findings. Generally, experimental group performance was significantly superior to control group performance. In some cases, gender acted as a significant between group and variable. Data for each clinical interview tended to follow a similar pattern.

When the experimental and control groups were compared overall, differences were significant at the .001 level. Significance was not as strong for females as for males.

In the experimental group, males and females did not differ significantly for living according to chi-square, but they did differ at the .05 level for floating. Experimental and control group females did not differ significantly. Control males and experimental males differed from control females and experimental females. All differences favored the experimental group, especially the males.

Significant differences were found in the use of causal relation of animism and dynamism when the independent variables of vocabulary, and state of development were considered.

From the results of this study it was concluded that causal relationships of animism and dynamism could be taught to fourth-grade children. Those children who were classified as concrete operational had acquired the necessary cognitive structures to conserve, do reversible thinking, and make multiple comparisons.

An Experimental Study into the Effect of Science Teaching on the Fourth-Grade Child's Concept of Piagetian Physical Causality

by

Louise L. Gann
Alcoa Elementary School
Alcoa, Tennessee

H. Seymour Fowler
The Pennsylvania State University
University Park, Pennsylvania

Introduction

We are presently so deeply involved in the scientific age that we have forgotten how recently it was that the scientific age began. It has been said that over half of the world's scientists who lived at the beginning of the scientific age are still living today.

Our view of science today is vastly different from that of twenty-five or thirty years ago.

The revival of interest in the theories of Piaget with emphasis on a definite order of stages in the cognitive development of a child's concepts seems to hold real possibilities for a more rational approach in determining a sequence of learning experiences in science.

Education has not yet developed a model that can be used to determine what content should be taught to which age group. Such an evaluation model is implicit in the work of Piaget.

> Piagetian theory indicates, the critical factor for educators to consider is "not" the chronological age of students, but their degree of intellectual development. . . . According to Piaget youngsters using concrete reasoning "operate on 'objects' and not yet on verbally expressed hypotheses." Concrete operational thought deals with reality. (Renner, 1978, p. 30)

Long-term studies by Almy, Chittenden, and Miller (1966) and Kohlberg (1966) helped to establish the authenticity of the stages theorized by Piaget as indicative of intellectual development in children.

Beilen (1965), Marmelstein (1967), Weiner (1968), and Rothenberg and Orst (1969) did research into conservation skills and the acceleration of the acquisition of conservation skills. On a majority of the studies it was shown that it was impossible to accelerate the course of development for either conservation or classification in children.

A major study by Laurendeau and Pinard in 1962 investigated the original Piagetian research into the causality of children. Five hundred subjects, 250 boys and 250 girls from four to twelve years of age, were used in this study.

In their study of the concept of living, the causal notion of animism, Laurendeau and Pinard found that as late as eleven or twelve years of age many children were using animistic thinking as part of their explanations.

Generally, Laurendeau and Pinard agree with Piaget and his assertion that children progress through various stages but assert that children should be assigned to different age levels than were assigned by other studies reviewed.

The second area of the Laurendeau and Pinard study concerned itself with the floating and sinking of objects. The findings have a tendency to substantiate the notion of the developmental levels suggested even though there were some areas of difference.

In 1963 Inbody utilized the clinical interview technique with 50 suburban kindergarten children using sixteen physical phenomena found

in elementary science texts. In the Inbody study it is possible to see at least two of the stages in the dynamistic conception of floating defined by Piaget.

There is, therefore, need for research into the acceleration of causality to fill the gap existing in the present knowledge of the child's ability.

Statement of the Problem

The purpose of this study was to investigate the effect of selected science experiences on the fourth-grade child's concept of Piagetian physical causality.

More specifically, the investigator sought to determine the answers to the following questions:

1. To what extent does science teaching affect the fourth-grade child's concept of Piagetian physical causality?

2. Is there a gender difference in the effect of science experiences on the fourth-grade child's concept of Piagetian physical causality?

3. Is there a correlation between the child's verbal ability and the fourth-grade child's concept of Piagetian physical causality?

4. Is there a difference in concept of causality between children who have changed in developmental stage and children who have not?

Hypotheses of the Study

The hypotheses of this study were derived from the basic assumptions: (1) that an ability to use causal relations is necessary for the development of scientific understandings and (2) that an understanding

of causality can be developed in the science class through teaching. Since an understanding of causal relations is assumed to be basic, science experiences in the elementary school should either be suited to the child's conception of causality as it exists or (3) be such that the experiences can change the concept of causality possessed by the child. It is on this latter assumption that the hypotheses for the study are based.

Hypothesis 1

Fourth-grade students who have participated in selected science experiences will not differ in their concepts of Piagetian physical causality from those who did not participate in the selected science experiences.

Hypothesis 2

There will be no correlation between the concept of Piagetian physical causality and verbal abilities of the children when the verbal is considered to be a score obtained by the child on the Metropolitan Achievement Test Form F.

Hypothesis 3

There will be no significant difference in concept of Piagetian physical causality between the scores of children in the preoperational, transitional, and concrete stages of development when stage is measured by the Concept Assessment Kit -- Conservation Form A.

Hypothesis 4

There will be no significant difference in concept of Piagetian physical causality between the scores of children who have shown a change in developmental level and those not having shown a change in level.

Methodology

Fourth-grade students were selected for this study since children in this age group were hypothesized by Piaget to be causal in their explanations of many physical phenomena. Physical causality according to Piaget is a term denoting the child's concept of the reason for, or the origin of, some naturally occurring phenomena; more specifically, one of the seventeen types of reasoning used by children in explaining the cause of a particular phenomenon; a relation which exists between the mind of the child and the external world. The study of causality is the study of relations that exists between the mind of the child and the external world (Piaget, 1972). The sample of 114 was the entire population of children enrolled in the fourth-grade science class in the Alcoa Elementary School, Alcoa, Tennessee. Students were randomly grouped and enrolled in the same curriculum.

The study was divided into five phases beginning with the selection of students, assignment to control and treatment groups, testing, teaching, posttest and analysis of data.

Four instruments were used in the study.

1. The Metropolitan Achievement Test (Form F)
2. The Concept Assessment Kit - Conservation (Form A)
3. Clinical Interview I - Concept of Living
4. Clinical Interview II - Concept of Floating

Three of the four tests are designed to be administered to individual children. Two were administered individually, one was administered to the entire group, and one via video tape by the investigator.

Instructional Procedures

Four intact classes containing 29, 29, 28, and 28 students were randomly assigned to two control and two experimental groups. Each class received similar daily instruction by the other teachers in all other subject areas throughout the experimental period. Only one class period daily for each student was utilized for the experiment.

Treatment group students were provided with materials for each of the ten lessons which was approximately 30 minutes in length followed by competency measure lessons. The control groups were provided with materials emphasizing language arts skills rather than science concepts. The ten lessons were approximately 30 minutes. Each child received a total of 300 minutes instruction.

Summary of Findings

The data analysis revealed significant findings in all four factors being investigated. These areas were groups, sex, vocabulary, and developmental stage.

The experimental group was in general significantly superior to the control group (Hypothesis 1.0).

The relationship between physical causality and verbal ability was established (Hypothesis 2.0). A strong relationship was indicated with a correlation existing between verbal ability and the scores from both clinical interviews.

A relationship was established between the concept of causality and the developmental stage. The comparison of control preoperational children's scores and experimental preoperational children's scores produced no difference between the groups for either clinical interview

(Hypothesis 3.1). Both the experimental transitional stage children and the concrete operational stage children had scores significantly higher than the same developmental stage groups of the control groups (Hypotheses 3.2, 3.3). In general, exposure to the introduction of selected science experiences tends to enhance or accelerate the internalization of the concept of causality.

Scores for the groups defined were subjected to additional analyses. The Kruskal-Wallis analysis of variance by ranks test was applied to the data. Significant chi-squares were found in both instances: 24.17 for Living and 26.93 for Floating. Both were significant at the .001 level. Analysis of variance showed a significant difference in both instances as F was 10.56 for Living and 8.27 for Floating. Both values were significant at the .001 level. A post-hoc analysis showed that male and female experimental groups differed from their control group counterparts for Living favoring the experimental group. Experimental group males differed significantly from the other three groups for Floating favoring the males.

The 't' tests showed that experimental group males differed significantly from their control group counterparts for both interviews. For Living, the 't' value was -4.65; for Floating, -4.25. Both values were significant at the .001 level and favored the experimental group. Rank order correlations (Spearman's rho) were .54 for Living and .50 for Floating. Both values were significant at the .01 level.

The 't' tests showed that experimental group females differed significantly from their control group counterparts. For Living, the 't' value was -3.22; for Floating, -2.03. The first value was significant

at the .01 level and the second value was significant at the .05 level. Both values favored the experimental group. Rank order correlations (Spearman's rho) were .38 for Living and .30 for Floating. The first value was significant at the .01 level and the second was significant at the .05 level.

In the experimental group, Spearman's rho for sex and Living was -0.19 and insignificant. For Floating, the correlation was -0.32 and significant at the .05 level favoring the males.

In the control group, Spearman's rho for sex and Living was .02. For sex and Floating, the value was -0.02. Neither value was significant.

Spearman's rho for the relationship between physical causality and verbal ability was .61 for Living and .50 for Floating. Both values were significant at the .001 level. The Pearson product moment coefficient of correlation was .59 for Living and .48 for Floating. Both values were significant at the .001 level for those above average in verbal ability.

Analysis of variance was used to determine the role of developmental stage with regard to physical causality. For Living, F was 12.93 and significant at the .001 level. A post-hoc analysis revealed that the concrete operational group differed significantly from the preoperational group and the transitional group. For Floating, F was 8.61 and significant at the .001 level. A post-hoc analysis revealed that the concrete operational group differed significantly from the preoperational group and the transitional group favoring the concrete operational.

The results of the study indicate that causal relations can be taught to children that are classified as concrete operational; since they had apparently acquired the necessary cognitive structures to conserve, do reversible thinking, and make multiple comparisons.

The fourth-grade children in this study were found to be at three different levels of development as suggested by Piaget and established in long-term studies by Almy, Chittenden, and Miller (1966) and Kohlberg (1966).

The findings of the present study differed from those of Beilen (1965), Marmelstein (1967), Weiner (1968), and Rothenberg and Orst (1969) in that on a majority of those studies it was shown that it was impossible to accelerate the course of development for either conservation or classification in children.

Implications

The fourth-grade children in this study were found to be at three different levels of development. These findings suggest that these levels did influence the results in the teaching of the causal relations of animism and dynamism.

Sex differences favoring the males were evidenced. It may be due to cultural differences in the treatment of males and females. If this is true the science curriculum needs restructuring to provide remedial instruction so that males and females could compete on an equal basis.

The concrete operational stage child appears to learn causal relations more readily than the transitional or preoperational stage child. Consequently stage of development should be considered in curriculum planning.

Suggestions for Further Research

1. The basic study should be repeated with some of the following alterations:

   a. A larger sample of children to determine whether similar findings are evidenced with children in the concrete and transitional stages of development in other environments.

   b. A longer period of time devoted to the teaching phase to determine if more intensive instruction would cause a change in more children's causal thinking.

   c. A control group of children who have not been exposed to children in the experimental phase of the study.

   d. Similar research should be conducted with other types of causality as a major variable to determine if teaching can cause changes in the use of causality types other than animism and dynamism.

   e. The study should be replicated using the cognitive dissonance technique to determine if it can enhance the learning of causal relations.

   f. The same study could be conducted in sex-segregated schools where sex stereotypes for girls are not as strong to determine whether typical sex roles do influence the learning of animism or dynamism.

   g. The present study could be conducted with additional posttesting to determine if the learning was permanent.

Bibliography

Almy, Millie; Edward Chittenden; and Paula Miller. Young Children's Thinking, Studies of Some Aspects of Piagetian Theory. New York: Teacher's College Press, Teachers College, Columbia University, 1966.

Anderson, Ronald D. Children's Ability to Formulate Mental Models to Explain Natural Phenomena. Journal of Research in Science Teaching, 1965, 3, 326-332.

Beilen, H. Learning and Operational Convergence in Logical Thought Development. Journal of Exceptional Child Psychology, 1965, 2, 317-339.

Inbody, Donald P. Children's Understanding of Natural Phenomena. Science Education, 1963, 47, 270-278.

Kohlberg, L. Cognitive Stages and Pre-School Education. Human Development, 1966, 9, 5-17.

Laurendeau, Monique and Adrien Pinard. Causal Thinking in the Child. New York: International Universities Press, 1962.

Lavatelli, Celia S. Piaget's Theory Applied to an Early Childhood Curriculum, A Center for Media Development. Boston: American Science and Engineering, Inc., 1973.

Marmelstein, J. Training Techniques for the Concept of Conservation Journal of Educational Psychology, 1967, 13, 185-200.

Piaget, Jean. The Child's Conception of the World. New York: Harcourt, Brace & Co., 1929.

Piaget, Jean. The Child's Conception of Physical Causality. Totowa, New Jersey: Littlefield, Adams, and Company, 1930.

Piaget, Jean. Construction of Reality in the Child. New York: Basic Books, Inc., 1954.

Piaget, Jean. The Origins of Intelligence in Children. New York: International Universities Press, 1969.

Piaget, Jean. Judgement and Reasoning in the Child. Totowa, New Jersey: Littlefield, Adams, and Company, 1972.

Renner, John W. Research Teaching and Learning with the Piaget Model. Norman, Oklahoma: University of Oklahoma Press, 1978.

Rothenberg, B. B. and J. H. Orst. The Training of Conservation of Number in Young Children. Child Development, 1969, 40, 707-726.

Weiner, G. A. Induced Set and Acquisition of Number Conservation. Child Development, 1968, 39, 195-205.